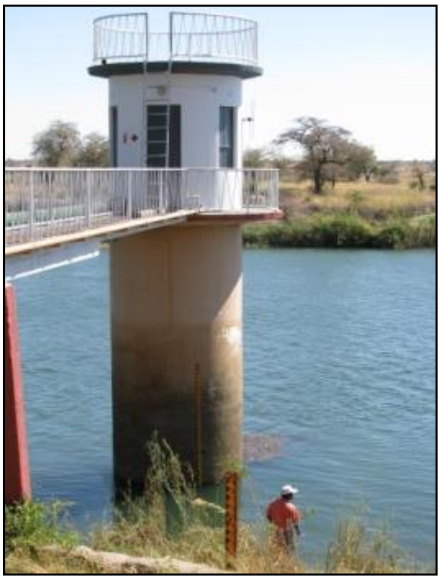
REPUBLIC OF NAMIBIA

MINISTRY OF AGRICULTURE, WATER AND FORESTRY

EoI 1/18/2 – 02/2011

A PRE-FEASIBILITY STUDY INTO:

THE AUGMENTATION OF WATER SUPPLY TO THE CENTRAL AREA OF NAMIBIA AND THE CUVELAI



PART I: CENTRAL AREA OF NAMIBIA
PART II: CUVELAI AREA OF NAMIBIA

PROJECT MEMORANDUM ON PHASES 2 AND 3 (ENGINEERING COMPONENT)

29 SEPTEMBER 2015

SUBMITTED BY:

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IN JOINT VENTURE WITH

SCE CONSULTING ENGINEERS

WITH SUB-CONSULTANTS

MRCE

ENVES

AND OTHERS

PREFACE

This document serves to provide an update on the *Pre-Feasibility Study into the Augmentation of Water Supply to the Central Area of Namibia and the Cuvelai* in terms of the water supply options and concept schemes identified under Phase 2 of this Project. These water supply options and concept schemes need to be approved by the Project Steering Committee for further analysis, by both the Engineering and Environmental and Social Consultancy Teams, under Phase 3 of this Project.

The main objective of this Pre-Feasibility Study is to examine all the nominally feasible options for augmenting the water supply to the Central and the Cuvelai Areas of Namibia where existing sources might become inadequate in the near future. In terms of alleviating the supply shortfalls which are expected to occur in the future, additional water sources are to be examined on the basis of augmentation and back-up – i.e. whether the proposed source and / or scheme is to serve for augmentation and / or supply, is to be investigated.

This Pre-Feasibility Study will be undertaken in three main phases as follows:

1. Phase 1: Investigations and Water Demands,
2. Phase 2: Modelling and Concept Schemes,
3. Phase 3: Engineering and Environmental Evaluations.

- Phase 1 of the Project was concluded with the submission of the Interim Reports No. 1 for the Cuvelai and CAN areas on 25 July 2015.
- Phase 2 is at an advanced stage, with the completion in July 2015 of the first round of public participation and stakeholder consultation meetings in Rundu, Oshakati and Windhoek and is scheduled for completion by the end of 2015. However, it was suggested at Meeting No. 14 of the Project Steering Committee, on 11 September 2015, that the remaining work under the Project, i.e. Phase 3 and the remaining work of Phase 2, be combined into one remaining “phase” or report. In order to execute this proposal, approval of what work is to be performed under Phase 3 (as previously envisaged) is required from the Project Steering Committee.

This document therefore aims to provide a proposal for the concept schemes to be analysed further under Phase 3 of the Project, which is to be approved by the Project Steering Committee before work on Phase 3 commences.

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1. INTRODUCTION

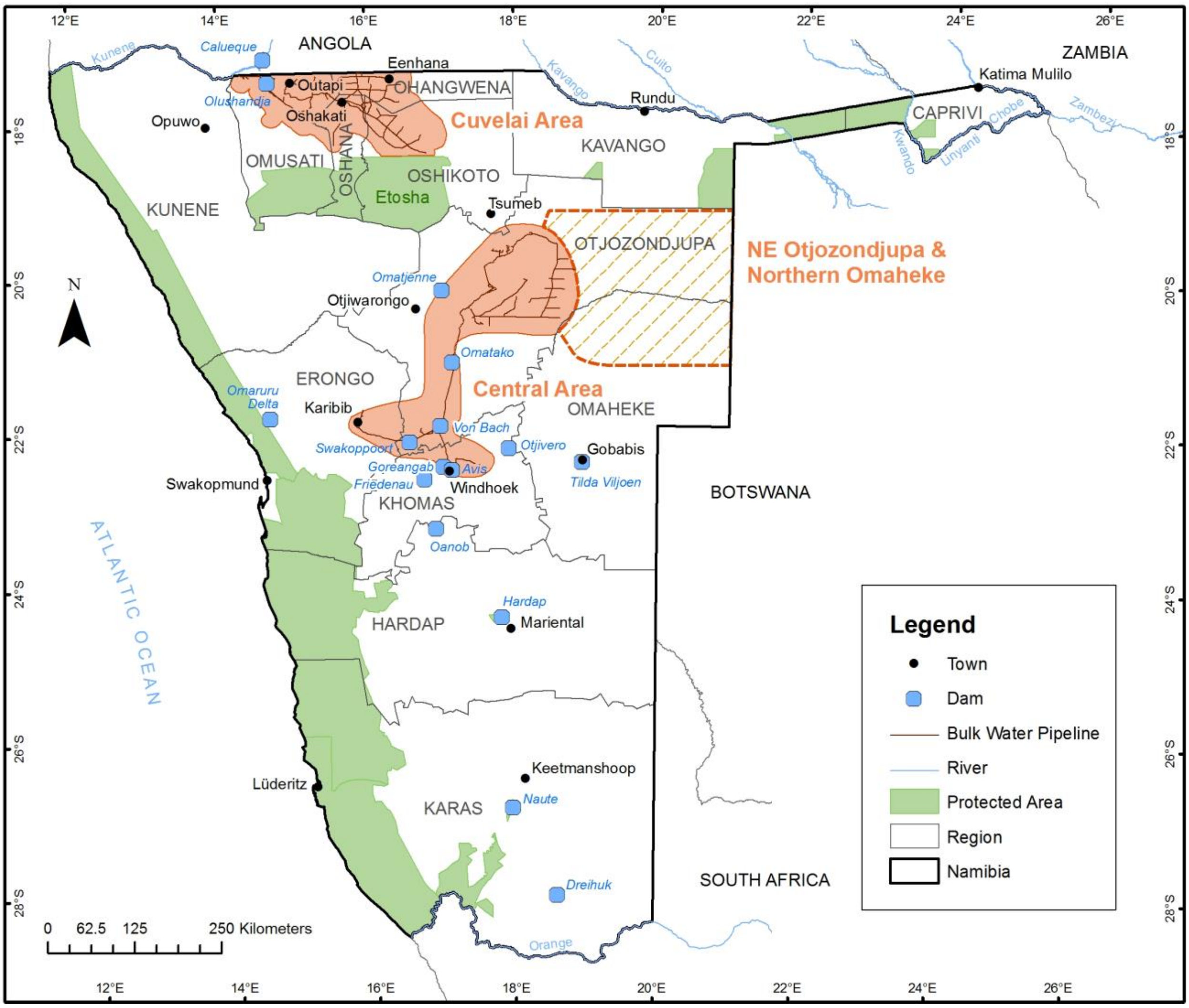
1.1 PROJECT OBJECTIVE

The main objective of this Study is to examine all the nominally feasible options for securing the long term, up to 2050, water supply to the Central Area of Namibia (**CAN**) and the Cuvelai area of Namibia where existing sources might become inadequate in the near future.

1.2 PROJECT AREA

The initial water supply area for the Study consisted of the Central Area of Namibia (**CAN**) and the Cuvelai area, which latter area corresponds with the largest portion of the four north central regions, being the Omusati, Oshana, Ohangwena and Oshikoto Regions.

Figure 1.1: Preliminary Extent of the Study Area



During the compilation of the ToR for this Study, it was decided that the area east of Okakarara as far as Gam, as well as Otjinene and the areas south to Rietfontein, including Okondjatu, Talismanis, Gam and Tsumkwe be included in the investigation, as well as the areas along the Okavango River upstream of Rundu and the areas along any proposed pipeline route from the Okavango River. It was furthermore agreed that other areas which experience water shortages from time to time such as Omaruru, Otjimbingwe; both urban and rural, including the resettlement farms included in the Otjimbingwe bulk supply, and Otjiwarongo, after local sources are fully developed, also be included in the Project Area.

1.3 OVERALL PROJECT APPROACH AND METHODOLOGY

1.3.1 Overall Project Methodology

The overall methodology followed with the execution of this Study was the following:

Phase 1: Investigations, water demands and water sources

1. Analysis and confirmation of the Project Area, including which areas of the Central Area of Namibia (**CAN**) and the Cuvelai are to be served for back-up and / or for augmentation purposes,
2. Determination of the realistic water demands for the Project Area, being the following areas initially included in the Project Area (later confirmed):
   a. The CAN,
   b. The Cuvelai area,
   c. The Eastern Otjozondjupa and Omaheke Regions,
   d. Other areas which experience water shortages from time to time such as Omaruru, Otjimbingwe; both urban and rural, including the resettlement farms included in the Otjimbingwe bulk supply, Otjiwarongo, after local sources are fully developed, Otjinene, Okondjatu, Talismanis, Rietfontein, Gam and Tsumkwe,
3. Analysis of the potential savings or reductions in water demands which can be realised from intensified water demand measures (realistic water demands),
4. Updating and confirming the capacities of the various currently available water supply sources,

Phase 2: Modelling and Concept Schemes

5. A comparison of the water demands to be met over the planning horizon with the capacities of existing water supply sources in order to determine the expected extent and timing of supply shortfalls,
6. Establishing as far as possible the expected or potential capacities of fu additional water supply sources,
7. A comparison of the expected shortfalls (using current supply sources) with the expected capacities of additional water supply sources in order to determine which additional or combination of additional water supply sources are suitable and will be required in the future,
8. Preparing concept configurations and cost estimates for supply schemes to develop the suitable future or additional water supply sources,
9. Preparing financial analyses for the most feasible future / additional supply schemes up to the level of Dynamic Prime Cost (**DPC**),

10. Providing the technical information to the environmental / social team in order for them to assess the likely environmental impacts and costs of the various options considered,
11. Considering the results of the financial analyses of the proposed future schemes, the environmental impacts and costs as well as other considerations, to select the overall optimum or best trade-off (most financially viable, economically beneficial and environmentally acceptable) future water supply schemes which are to be investigated in further detail in a following stage of this overall Project.

Phase 3: Evaluation of schemes

Items 9 to 11 are to be undertaken under the originally envisaged Phase 3 of the Project.

1.3.2 Originally Envisaged Project Phases and Milestones

The Engineering Consultant proposed in the Engineering Inception Report (Technical Component) of 30 April 2013 that the Project be separated into three phases which correspond to different major activities or components of the Project and that each of these phases or components be concluded with the submission of a report. The first two phases would conclude with an Interim (Progress) Report and the third phase with a Final Report for the Pre-Feasibility Study. Each of these reports would serve as milestones to conclude the associated phase of the Project.

The three main phases proposed for the Project were as follows:

1. Phase 1: Investigations and Water Demands,
2. Phase 2: Modelling and Concept Schemes,
3. Phase 3: Engineering and Environmental Evaluations.

These phases were proposed (and so structured) in order to conclude tasks and activities which would form the basis or foundation of the evaluations or investigations of the subsequent and following phase(s). For example, under Phase 1, the water demands would be determined for the various portions of the Project Area, following which, under Phase 2, the demand / supply modelling would be conducted, based on the water demands determined under Phase 1.

It was proposed that approval of each milestone is required by the PSC before the Consultant would commence with the tasks and activities earmarked for the following phase of the Project. In addition to the major project milestones corresponding to the submission of Interim (Progress) Reports or the Final Report, it was envisaged that two of the Progress Meetings to be held with the PSC would also serve as milestones.

The key activities under each Project phase, the associated milestone and the approval component referred to above – **as originally envisaged in the Engineering Inception Report (Technical Component) of 30 April 2013** – are summarised in **Table .1** below.

Table 1.1: Project Phases, Milestones and Approval as Originally Envisaged

Project Phase	Key Activities	Key Outcomes	Milestone	Approval Required by the PSC
Phase 1	Establishment of water supply areas (CAN, Cuvelai and other). Investigations and determination of water demands. Establishing the capacity of existing and potential water sources.	(1) Water demand projections (2) Yield of existing and potential water sources	Interim Report and Report Discussion	(1) Water demand projections (2) Yield of existing and potential water sources
Phase 2	Modelling and investigations and the development of concept schemes	(1) Configuration of the proposed concept schemes	Progress Meeting prior to 1st Public Participation Meeting	(1) Configuration of the proposed concept schemes
			Interim Report and Report Discussion	(1) Configuration of the proposed concept schemes
Phase 3	Technical feasibility (costing, financial analyses), environmental feasibility and hence overall feasibility.	(1) Technical feasibility (2) Environmental feasibility (3) Overall feasibility	Progress Meeting prior to 2nd Public Participation Meeting	(1) Overall favoured water supply alternatives
			Draft Report, Report Discussion and then Final Report	Pre-Feasibility Study

1.4 REVISED PROJECT APPROACH

1.4.1 Request and Proposal for a Revised Approach

During Meeting No. 14 of the Project Steering Committee, on 11 September 2015, it was suggested that the remaining work under the Project, i.e. Phase 3 and the remaining work of Phase 2, be combined into one remaining “phase” or report.

The Engineering Consultant was called to an ad-hoc meeting at the MAWF on 16 September 2015 and requested to expedite the completion of this Project. By combining the remaining work of Phase 2 and that of Phase 3, completion of the engineering assessments can be expedited.

1.4.2 Completed and Remaining Work

An assessment of the completed and remaining work under Phases 2 and 3 of the Project is provided by way of annotations to **Table 1.1**, in **Table 1.2**.

Table 1.2: Project Phases, Milestones and Approval as Originally Envisaged: Progress Update

Project Phase	Key Activities	Key Outcomes	Milestone	Approval Required by the PSC
Phase 1	Establishment of water supply areas (CAN, Cuvelai and other). Investigations and determination of water demands. Establishing the capacity of existing and potential water sources.	(3) Water demand projections (4) Yield of existing and potential water sources	Interim Report and Report Discussion	(3) Water demand projections (4) Yield of existing and potential water sources
Phase 2	Modelling and investigations and the development of concept schemes	(2) Configuration of the proposed concept schemes	Progress Meeting prior to 1st Public Participation Meeting	(2) Configuration of the proposed concept schemes
			Interim Report and Report Discussion	(2) Configuration of the proposed concept schemes
Phase 3	Technical feasibility (costing, financial analyses), environmental feasibility and hence overall feasibility.	(4) Technical feasibility (5) Environmental feasibility (6) Overall feasibility	Progress Meeting prior to 2nd Public Participation Meeting	(2) Overall favoured water supply alternatives
			Draft Report, Report Discussion and then Final Report	Pre-Feasibility Study

Progress Update and Comments

Phase 1 of the Project was concluded with the submission of the Interim Reports No. 1 for the Cuvelai and CAN areas on 25 July 2015.

The Phase 1 Reports have not yet been signed off by the MAWF. However, at Meeting No. 10 of the Project Steering Committee on 05 August 2014, the Engineering Consultant was instructed to proceed with Phase 2 of the Project.

Draft specialist report into the Water Resources Yield Assessment of the Kunene River and Drought Analyses submitted on 27 November 2014 and again on 20 May 2015 and 16 September 2015. Report not yet signed off by the MAWF.

The 1st round of public participation and stakeholder consultation meetings under Phase 2 of the Project were successfully concluded in Rundu (21 July), Oshakati (22 July) and Windhoek (24 July 2015).

Following the 1st round of public participation and the availability of the Environmental and Social Assessments, the configuration of the proposed concept schemes is to be prepared to conclude Phase 2 of the Project. Approval by the PSC of the configuration of the proposed concept schemes required to conclude Phase 2 of the Project.

Assessments to be conducted on the approved concept schemes (as under Phase 2) under Phase 3 of the Project.

1.4.3 Remaining Work under Phase 2 of the Project

The remaining work required to conclude the Engineering Component of Phase 2 of the Project is as follows:

1. For the Part I: The Central Area of Namibia:
    a. Calculate the water demands of the existing consumers and schemes drawing water from the Okavango River in Namibia,
    b. Determine the total expected future abstraction from the Okavango River by Namibia, for existing and proposed consumers and schemes,
    c. Describe the concept schemes under which water can be supplied from the Okavango River to the CAN (for further analysis under Phase 3),
    d. Submit Interim Report No. 03 for Part I: The Central Area of Namibia detailing the analyses carried out under Phase 2 of the Project,
2. For the Part II: The Cuvelai Area of Namibia:
    a. Determine the water demands for emergency / lifeline supply for humans and animals in the Cuvelai area,
    b. Determine which supply zones can be supplied from the Ohangwena II Aquifer,
    c. Formulate a combination of options for alternative / back-up supply to the Cuvelai Area,
    d. Submit Interim Report No. 01 for Part II: The Cuvelai Area of Namibia detailing the analyses carried out under Phase 2 of the Project.

1.4.4 Work under Phase 3 of the Project

Phase 3 of the Project, on the part of the Engineering Component, entails the technical and financial analyses of the concept schemes / options put forward and approved by the PSC under Phase 2 of the Project.

1.4.5 Revised Project Approach and this Memorandum

The remaining work of Phase 2 and that of Phase 3 can be combined, in order to expedite the completion of the engineering assessments for this Project. However, in order to conduct the assessments required under Phase 3 of the Project, approval by the PSC of the concept schemes is required. This was envisaged to follow from the Interim Report submitted to conclude Phase 2 of the Project. If Phases 3 and 3 are combined, the submission of this report will fall away, and therefore this Memorandum is submitted to describe the concept schemes, which are to be approved by the PSC for the Engineering Consultant to proceed with Phase 3 of the Project.

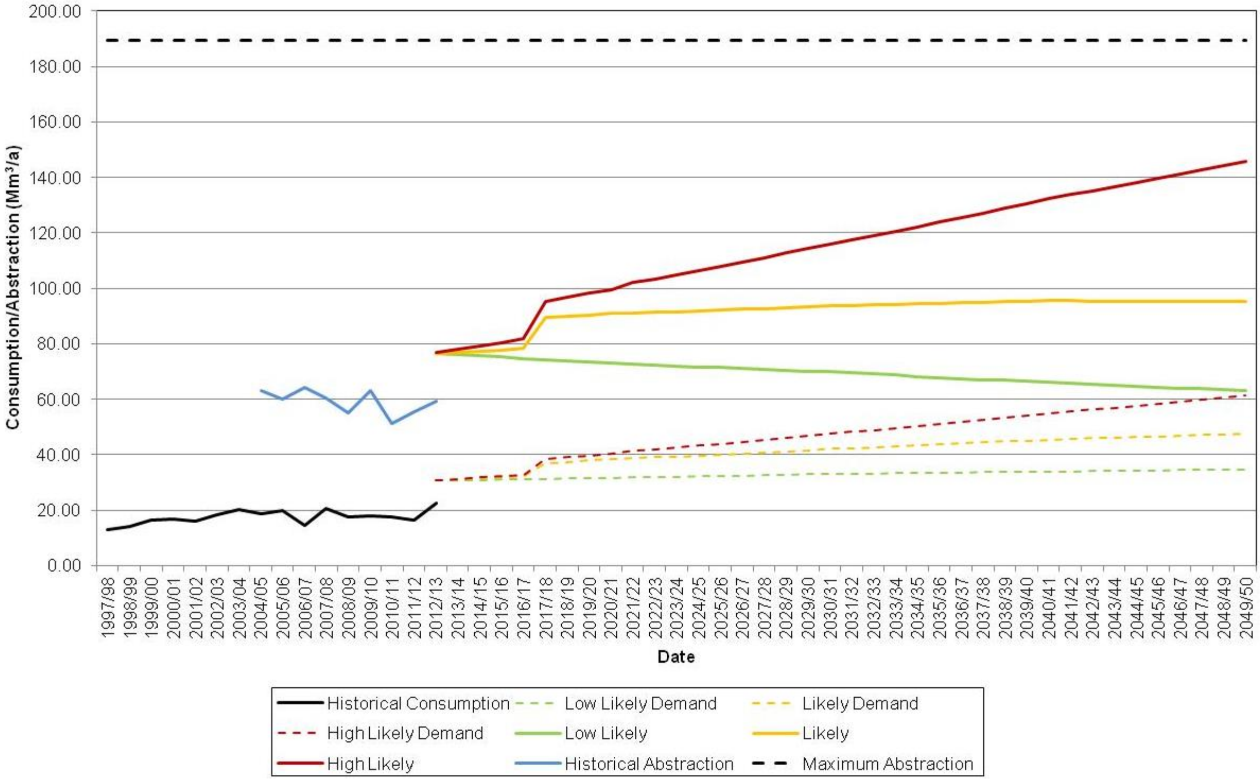
2. CONCEPT SUPPLY CONFIGURATION FOR THE CUVELAI AREA OF NAMIBIA

2.1 CONTINUED SUPPLY TO THE CUVELAI AREA FROM THE KUNENE RIVER AT CALUEQUE

The default or “do nothing” future water supply to the Cuvelai Area will comprise the continued supply to the area from the Calueque Dam in Angola via the Calueque – Oshakati Canal.

For all water demand scenarios prepared under this Project, the projected abstraction volume at Calueque is below the maximum allowable abstraction limit (6 m^3/s to Namibia) from the Kunene River, although this does not necessarily imply that the flow rate in the river will in future allow this abstraction rate.

Figure 2.1: Historic and Estimated Abstraction Requirements for the Cuvelai Area



In the context of continued abstraction from the Kunene River at Calueque, the yield analysis for the Kunene River has shown the following:

1. The maximum yield at Ruacana occurs following the rehabilitation of Calueque Dam and with optimised spills and minimised releases from Gove Dam upstream. This would require improved cooperation between Namibia and Angola, via the PJTC, regarding operation of the Gove and Calueque Dams, and subsequent streamflow regulation. This is also the only scenario modelled which complies with the minimum requirement of 50 m³/s streamflow downstream of Ruacana.
2. The yield at Ruacana reduces significantly with increased abstraction from Calueque Dam (as being planned for irrigation purposes by Angola). Increased abstraction in the Upper and Lower Kunene River further lowers the expected yields at Ruacana. These scenarios clearly illustrate the impact of increased abstraction and water use by Angola upstream of Calueque / Ruacana.

It has been reported that Angola is planning major irrigation schemes and other developments along the Kunene River at and upstream of Calueque. In this context, in order to guarantee flows downstream of Ruacana for the downstream aquatic environment and hydropower generation, upstream abstraction may need to be limited or capped. Conversely, with unlimited upstream abstraction, there may be insufficient flow downstream of Ruacana for the downstream aquatic environment and hydropower generation.

It can therefore be concluded, that whilst the Kunene River should have sufficient capacity to meet the future water demands of the Cuvelai Area, this is highly dependent:

1. On the rehabilitation of Calueque Dam and the optimised operation of the Gove and Calueque Dams,
2. The abstraction by Angola in the Upper and Lower Kunene River and at Calueque.

Irrespective of the actual water abstraction upstream by Angola, it is therefore clear that the future availability of water to Namibia is dependant on upstream activities in Angola, which remains a risk outside the control of Namibia.

2.2 WATER SUPPLY OPTIONS CONSIDERED FOR THE CUVELAI AREA

A number of water supply options have been considered for either augmentation or back-up supply to the Cuvelai Area. The following water supply sources and options are being considered further as potentially viable alternatives for supply to the Cuvelai Area:

1. Water reuse and recycling.
    a. It is estimated that 0.757 Mm^3/a of water can be available for non-potable reuse in Oshakati, Ongwediva and Ondangwa; approximately 20% of the current volume of potable water supplied by NamWater,
    b. Assuming a 100% coverage of waterborne sanitation in these three urban areas in 2050, approximately 41% of the estimated future water demand could be available for non-potable reuse,
    c. Non-potable reuse of water is considered to be the most likely possibility in the Cuvelai area therefore, given the potential for public reticence or reservation in this matter, especially as this would be the first time that water reuse would be carried out on a large scale in the Cuvelai Area,
    d. Non-potable reuse for the irrigation of marketable crops, as being done on a small(er) scale at Outapi, be considered first, in order to make reuse as economically viable as possible, and thereafter for road construction, landscaping and the irrigation of sports fields and green spaces,
1. Supply from the Ohangwena II Aquifer. Investigations into the long-term sustainable yield and recharge of the aquifer are still ongoing by others, and information thereon is unavailable and unconfirmed. Current (preliminary) estimates are that a yield of 6 Mm^3/a is possible, which represents:
    a. In 2013: 36% of the current potable demand, 47% of human only demand,
    b. By 2050: 21% of the potable demand, 24% of the human only demand.
2. Pumping from the Kunene River at Ruacana, on Namibian soil, as was done in the past. This option, still under investigation, will have high capital and particularly energy and operational costs.

2.3 PROPOSED BACK-UP WATER SUPPLY CONFIGURATION FOR THE CUVELAI AREA

2.3.1 Proposed Changes to the Water Supply Configuration

Based on the above, the following back-up water supply configuration is proposed for the Cuvelai Area, for finalisation and further assessment under the remaining component of this Project:

1. The reduction in the storage volume of Olushandja, to an estimated 1 Mm^3, in order to reduce the high evaporation and seepage losses in the system, but still provide some limited reserve storage,
2. The construction of a new, large purification plant at Olushandja, to in time replace the existing plants at Olushandja, Outapi, Ogongo and Oshakati. This aims to reduce the losses in the system and addresses the provision of additional treatment capacity which is expected to become insufficient at Olushandja (±2038), Outapi (already currently) and Oshakati (shortly),
3. The construction of a pipeline to convey potable water from the proposed new Olushandja Purification Plant to Outapi, Ogongo and Oshakati:
    a. This aims to replace the canal for the purposes of *potable water supply*, to reduce the high evaporation and seepage losses in the system, the high levels of unaccounted for water and to provide water at a higher security of supply, by eliminating the pollution of water in the canal (lower treatment costs at Olushandja) and potential disruptions due to flood damage to the canal. A smaller Olushandja and reduced flow through the Olushandja – Oshakati Canal will reduced the overall non-revenue water which will reduce the abstraction requirements from the Kunene River and therefore the security of supply,
    b. The canal can be retained for stock watering, irrigation supply and informal water use, at a lower security of supply due to the potential impact of flooding on the operation of the canal,
4. Limited supply from the Ohangwena II Aquifer, following a proposed well-field development in the vicinity of Eenhana / Okongo,
    a. The area to be supplied depends on further revision / confirmation of the recharge and long-term sustainable yield of the aquifer, which is the subject of ongoing work by the BGR / Namibian DWAF,
    b. The current proposal is that supply would be via a new pipeline to one of the Ondangwa / Iindangungu / Omakango or Omafo Pump Stations for further distribution via the existing pipeline supply network,
    c. Given the fact that work into the Ohangwena II Aquifer is ongoing, and groundwater sources are generally understood only after several years of use, this is regarded as a longer-term back-up option,
5. The construction of a pipeline from the Headbay at Ruacana to the Canal, to transfer only potable water for human and livestock water use in the Cuvelai Area:
    a. From the Headbay to the top of the escarpment, a high pressure pipeline, base and booster pump station will likely be required (to be confirmed),
    b. A balancing reservoir will be required at the top of the escarpment,

   c. A gravity (pressure) pipeline could be provided from the balancing reservoir at the top of the escarpment to the discharge point in the Canal near where the Canal meets up with the C46 tar road between the Border and Olushandja Dam,
   d. It is currently proposed that the existing pipeline be replaced, but that approximately the same route and configuration be followed / employed,

Non-potable water reuse should be introduced in the urban areas of Oshakati, Ondangwa and Ongwediva, following a concerted public and general awareness campaign, to increase overall water use efficiency, lower source abstraction rates and hence increase the security of supply.

2.3.2 Proposed Future Water Supply Configuration

On the basis of the above proposals, the future supply configuration to the Cuvelai Area would be based on:

1. Supply from Calueque:
   a. For potable water at a greater security of supply than currently due to reduced demands as a result of non-potable reuse, increased efficiency and the reduction in non-revenue water from current levels (due to the reduction in size of Olushandja Dam and the piped water from a new purification plant at Olushandja to Oshakati),
   b. For potable water at a lower security of supply but also lower cost than from Ruacana, due to concerns w.r.t. access into Angola,
   c. For irrigation water at a lower security of supply,
   d. At a cost lower than the other alternatives proposed,
2. Back-up supply of potable water from the Ohangwena II Aquifer for a limited area of the Cuvelai system,
3. Back-up supply of potable water from Ruacana for the remaining areas of the Cuvelai system:
   a. Which is most likely only cost-effective for potable use at lower than current rates due to reduced demands as a result of non-potable reuse, increased efficiency and the reduction in non-revenue water from current levels (due to the reduction in size of Olushandja Dam and the piped water from a new purification plant at Olushandja to Oshakati,
   b. Which is at a higher security of supply (being entirely located on sovereign Namibian territory) but also higher cost than supply from Calueque,
   c. Which is not intended for irrigation use.

2.3.3 Proposed Scheme Configurations

Three (new) water supply schemes are proposed, together with the provision of a new purification plant at Olushandja.

2.3.3.1 Ruacana – Canal Pipeline

On the basis of the aforementioned, this option for water supply to the Cuvelai Area will need to consist of the following:

1. A new pipeline from the Ruacana Headbay, and possibly the tailrace as well (to be confirmed) to the Cuvelai area, which will consist of:
    a. A high pressure portion up to the escarpment,
    b. A gravity pressure portion from the escarpment to the Calueque – Oshakati Canal, as was previously used,
2. A pressure-break and balancing reservoir near the top of the escarpment,
3. New pump stations, including all mechanical equipment, power supply, controls etc. at:
    a. The tailrace (potentially), and
    b. Headbay of the hydropower plant,
    c. Interim location(s) between the hydropower plant and the escarpment as may be required.

The proposed pipeline routes are shown in **Figure 2.2** and **Figure 2.3**.

Figure 2.2: Proposed Pipeline Routes near the Ruacana Falls (Google Earth Image)

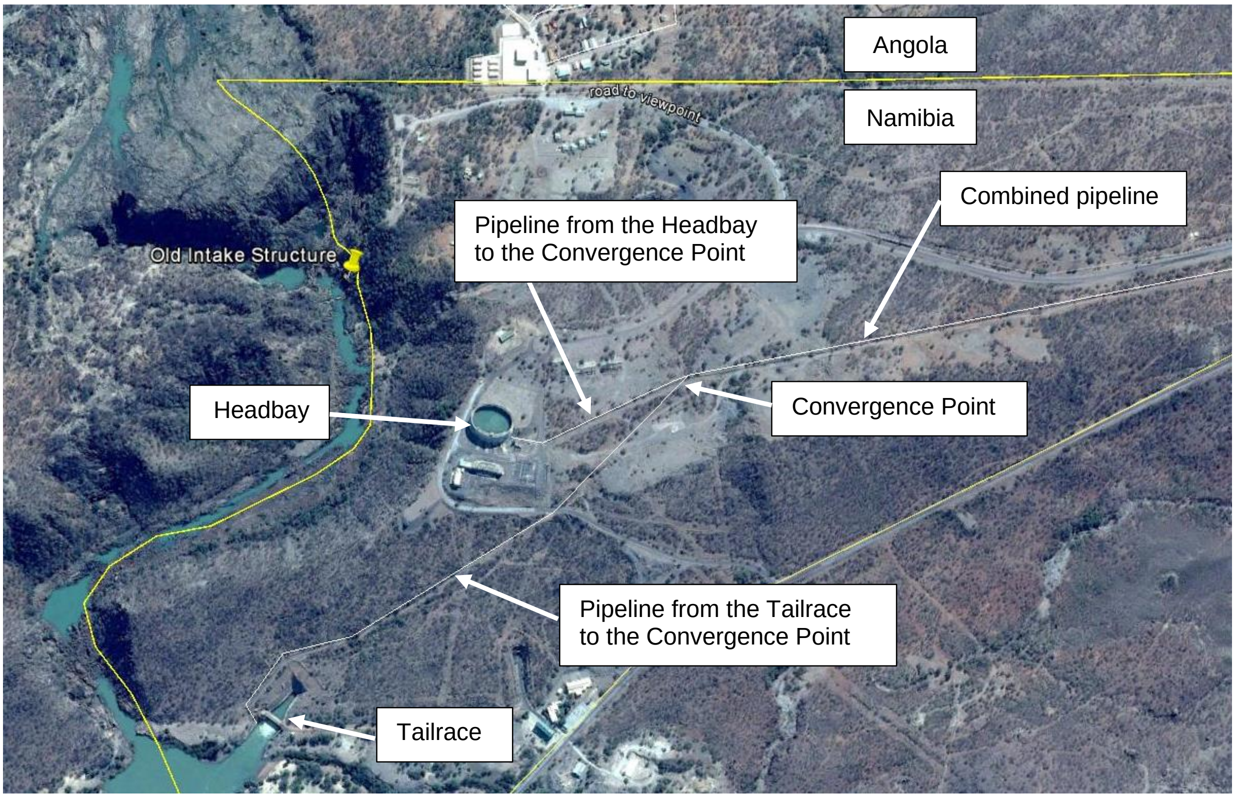
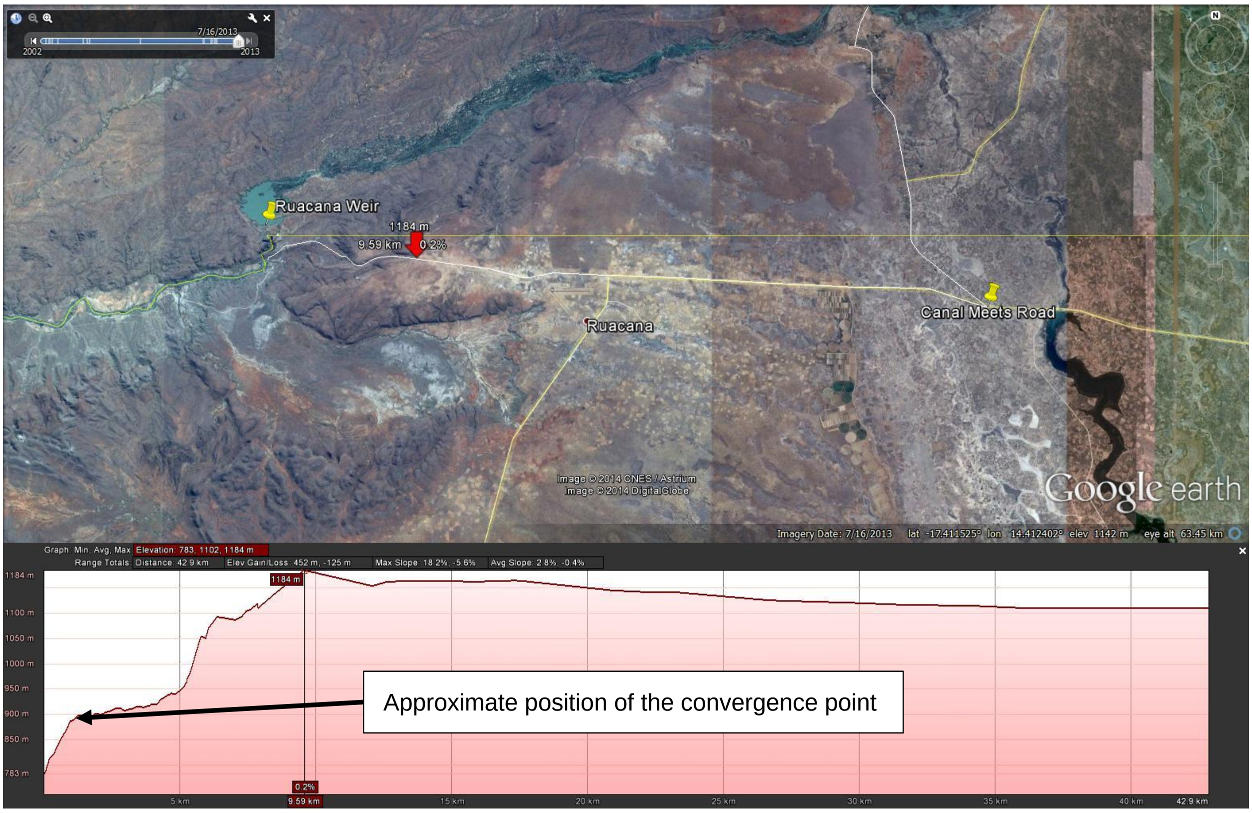


Figure 2.3: Proposed Pipeline Route from the Ruacana Tailrace to the Calueque – Oshakati Canal (Google Earth)



In terms of pipelines, the following are proposed:

1. High pressure pipeline from the Ruacana Headbay, and possibly the tailrace as well (to be confirmed) to the top of the escarpment:
    a. Along the alignment of the existing pipeline, which is to be removed and replaced,
    b. Above ground,
2. Gravity pressure pipeline from the top of the escarpment to the Canal (initially, later perhaps to the proposed Olushandja Purification Plant):
    a. Along the north side of the C46 Oshakati – Ruacana tar road,
    b. Buried (below ground).

2.3.3.2 Olushandja – Oshakati Pipeline

A pipeline to eventually replace the Olushandja – Oshakati Canal, at least for potable supply, is proposed as follows:

1. Pipeline alignment to be determined,
2. Booster pump stations as required,
3. Buried (below) ground pipeline.

2.3.3.3 Ohangwena II Wellfield and Supply Pipeline

This proposed scheme is to consist of the following (pending the outcome of ongoing work by the BGR / Namibian DWAF):

1. A well-field development in the vicinity of Eenhana / Okongo,
2. A collector reservoir near the wellfield development,
3. A base pump station near the collector reservoir,
4. A supply pipeline to one of the Ondangwa / Iindangungu / Omakango or Omafo Pump Stations for further distribution via the existing pipeline supply network:
    a. For potable supply only,
    b. Buried (below ground).

The location of the infrastructure and alignment of the pipeline need to be determined, pending further information from the BGR / Namibian DWAF Project.

3. CONCEPT SUPPLY SCHEMES FOR THE CENTRAL AREA OF NAMIBIA

3.1 CURRENT WATER SUPPLY SITUATION IN THE CENTRAL AREA OF NAMIBIA

In 2013 NamWater sold more water (32.85 Mm^3/a) than the long-term sustainable capacity of the existing resources (31.45 Mm^3/a). If treatment and transfer losses are factored into the sales, the required source abstraction (approximately 36.68 Mm^3/a) exceeded the sustainable resources by over 5 Mm^3/a. This means that in 2013 already, the CAN has been in a water deficit.

3.2 POTENTIAL WATER SOURCES FOR SUPPLY TO THE CENTRAL AREA OF NAMIBIA

3.2.1 Realistic Supply Options Investigated

All realistic potential water sources which could be developed to supply water to the CAN were investigated, including:

1. Apart from the Windhoek Aquifer, which as has the potential to be further developed under the Windhoek Managed Aquifer Recharge Scheme (WMARS), no other groundwater sources between the Karst area and Rehoboth have sufficient capacity to supply water to the CAN,
2. None of the Hardap, Oanob or Friedenau Dams have sufficient capacity to supply water to the CAN, and may themselves be oversubscribed in future,
3. The City of Windhoek (CoW) is currently planning the upgrade of the Gammams Waste Water Treatment Plant (GWWTP), which will allow the treatment of larger volumes of waste water to a better quality. This will allow the New Goreangab Water Reclamation Plant to run at its full capacity of 21,000 m^3/d, or 7.66 Mm^3/a – an increase of 2.66 Mm^3/a over the current capacity, which is estimated will be available from April 2017,
4. Following the upgrade of the GWWTP, the construction of an additional reclamation plant, to provide 4.2 Mm^3/a via advanced membrane technology is recommended. Further into the future, this system could be doubled, to provide a total of 8.4 Mm^3/a of additional water,
5. Water reclamation may be considered for towns in the CAN with a water consumption of greater than 1 Mm^3/a, for example Okahandja,
6. To improve water use efficiency in the CAN, it may be advisable to enforce the installation of dual pipe systems at least for parks (landscaping), sport fields and cemeteries in all new developments. The potential savings in potable water will vary from town to town but may be in the order of 7 to 15%.

3.2.2 Other Supply Options

Other supply options investigated previously and only updated under this Study include:

1. Covering of the Eastern National Water Carrier Canal: For savings estimated at between 0.8 and 1.1 Mm^3/a of a cost of MN$ 210 excluding VAT in 2004, this is not a viable supply option to the CAN,
2. Abstraction from the Kunene River: The Kunene River should be reserved for supply to the Cuvelai Area (the only supply source to the area) and hydropower generation. There is a risk that with increased abstraction upstream in Angola, capacity for supply to Namibia may be reduced,
3. Abstraction from the Orange River:
    a. Since the Orange River is further from Windhoek than the Okavango River is from Grootfontein, with greater pumping requirements, this option will remain more expensive than abstraction from the Okavango River, and is made more so with the requirement of another water treatment plant near Windhoek.
    b. With flow in the Orange River already highly regulated, and likely to become more so in the future, Namibia is very dependant on abstractions from and flow management of the upstream systems. With the projected future water demand of current users (mostly irrigation, but including supply to Noordoewer, Oranjemund, Rosh Pinah and Skorpion Zinc Mine) likely to be a multiple of the currently agreed share available to Namibia, it is uncertain whether additional water can be abstracted for supply to the CAN by Namibia.
    c. This option will therefore remain much more expensive and therefore less attractive than abstraction from the Okavango River and consequently does not constitute a viable water supply augmentation option for the CAN

3.2.3 Viable Long-Term Water Sources

Only two sources with sufficient capacity to supply the long-term water demands of the CAN could be identified, namely the Okavango River and the desalination of sea water.

The Engineering Consultant was called to an ad-hoc meeting at the MAWF on 16 September 2015 and informed that the MAWF will not extend the appointment of the Engineering Consultant to include an assessment of the supply of desalinated sea water to the CAN (which is not included in the ToR for this Project), as this option is not considered viable by the MAWF.

The Okavango River therefore represents the only remaining source with sufficient capacity for supply to the CAN and concept schemes for the supply of this water to the CAN are put forward in this Memorandum.

3.3 WATER SUPPLY FROM THE OKAVANGO RIVER TO THE CENTRAL AREA OF NAMIBIA

3.3.1 Advantages and Disadvantages of Supply from the Okavango River

Water supply to the CAN from the Okavango River is based on the following premises:

1. The Okavango River appears to have sufficient capacity for supply to the CAN, though this needs to be confirmed in the context of supply to existing consumers and schemes, particularly the Green Scheme irrigation developments and the potential supply to the currently undeveloped areas in the north-eastern Otjozondjupa and northern Omaheke Regions,
2. Flows in the Okavango River appear not to be correlated with the inflows into the 3 CAN dams (i.e. droughts in the CAN do not coincide with droughts in the Okavango River), which means that this is a source independent of the hydrological conditions in the CAN,
3. The transfer of water from the Okavango River to the CAN could make use of existing infrastructure, at least initially, though the sufficiency of the existing transfer schemes and infrastructure will still be confirmed with the further detailed analyses.

There are significant disadvantages to water supply to the CAN from the Okavango River, namely:

1. Competing water demands in the Kavango Regions and particularly with the irrigation demand of the Green Schemes (estimated to be 235 Mm^3/a vs 64 Mm^3/a required for the current extent of the CAN) may create a conflict w.r.t a possible abstraction limit / allocation to Namibia,
2. As with the Kunene River, flow in the Okavango River is highly dependent on abstraction upstream in Angola. This is expected to increase significantly in future, with the development of irrigation schemes and even a possible transboundary scheme transferring water from the Cubango River to the Cuvelai area of southern Angola,
3. Climate change effects may result in reduced or more erratic rainfall and hence runoff and flows in the Okavango River,
4. The Okavango Delta is a Ramsar site and now a World Heritage Site and any potential threat to this system will attract international attention,
5. There is no current water use agreement between the riparian states of Angola, Botswana and Namibia, which means that further water abstraction by Namibia will need to be negotiated at OKACOM, which may take some time to complete, which may delay the design and construction of the scheme,
6. Abstraction is currently only planned to 2050. Beyond this, the future demands are uncertain. If further into the future, demands have increased substantially, it is unlikely that the Okavango River will have sufficient supply capacity, given that other abstractions are likely to have increased as well (particularly upstream in Angola).

Measures which may mitigate against some of these disadvantages will be proposed where possible.

3.3.2 Abstraction Point

Previous investigations into the supply of water from the Okavango River to the CAN either primarily or only considered abstraction from the Cubango / Okavango River at or near Rundu. The assessments conducted under this Project show that the following factors are pertinent with regard to the flows in the Okavango River upstream and downstream of the confluence with the Cuito River:

1. With inflow from the Cuito River, the Mean Annual Volume of flow in the Okavango River almost doubles (5,464 Mm^3/a at Rundu upstream of the confluence vs. 9,773 Mm^3/a at Mukwe downstream of the confluence; factor of 1.8),
2. The median flows in the Okavango River reflect the near-doubling of the volume downstream of the confluence with the Cuito River (median flows are 109.76 m^3/s at Rundu upstream of the confluence and 248.48 m^3/s at Mukwe downstream of the confluence; a factor of 2.3),
3. However, there is a much greater difference in the low flows as a result of the base flow-like contribution of the Cuito River: the minimum flow on record at Rundu upstream of the confluence is 11.12 m^3/s, whilst the minimum flow on record at Mukwe downstream of the confluence is 74.73 m^3/s (a factor of 6.7),
4. As found by others (McCarthy et al., 2000) there is surprisingly little correlation between the annual discharge volumes in the Cubango / Okavango and Cuito Rivers, despite their catchment areas being adjacent to each other. Although the coefficient of determination (R^2) value for data between 1949/50 and 2012/13 (excluding some years, as noted elsewhere), at 0.123 is greater than the value of 0.030 determined by McCarthy et al. (2000), this still indicates a poor correlation. This can alternatively be expressed by the correlation coefficient of 0.35 for the annual volumes in the two rivers.

In the context of currently proposed volumes of abstraction from the Okavango River (65 to 103 Mm^3/a) which are much greater than those previously suggested (approximately 17 Mm^3/a in 1997), there are several advantages to abstracting water from downstream of the confluence with the Cuito River, namely:

1. Abstraction will have a much smaller impact on the average / median volume of flow and average / median flow rates in the river,
2. Abstraction will have a very much smaller impact on the low flows in the river,
3. With a poor correlation in volumes of flow between the Cubango / Okavango and Cuito Rivers, there is a greater likelihood of one of the catchment areas receiving rainfall and therefore generating flow, which is important as a mitigation measure to the possible effects of climate change,
4. With flow from two catchment areas upstream, the effects of upstream developments in Angola will be mitigated to some extent.

On the basis of the above, it is strongly suggested that the point of abstraction from the Okavango River be located downstream of the confluence with the Cuito River.

3.4 MEDIUM TERM WATER SUPPLY OPTIONS

Water supply schemes and options which are known about, which consist of efficiency improvements in the existing system, the upscaling and extension of existing sources and schemes, and which can be implemented within 2 to 5 years, are proposed as options to minimise supply shortfalls in the next 8 – 10 years whilst the long-term option is being further assessed and developed. These are:

1. Scenario 3: VBWTP supernatant recycling to reduce the losses at the plant (which NamWater is mostly doing already),
2. Scenario 4: 8 Mm^3/a recharge and 21 Mm^3/a abstraction capacity and 89 Mm^3 water bank for the Windhoek Aquifer under the WMARS project,
3. Scenario 6 Advanced reclamation be accepted as interim supply source for the first 8 years until 2023/24.

The assessment of medium-term options is not included in the ToR for this Project. These proposals will therefore not be analysed in further detail.

3.5 CONCEPT SCHEMES FOR THE WATER SUPPLY FROM THE OKAVANGO RIVER TO THE CENTRAL AREA OF NAMIBIA

3.5.1 General Considerations

The concept schemes to supply water from the Okavango River to the CAN are based on the following basic considerations and configuration:

- An abstraction point on the Okavango River downstream of the confluence with the Cuito River,
- A pipeline and booster pump stations to transfer water from the abstraction point to the start of the ENWC Canal near Grootfontein,
- Use of the existing CAN transfer schemes and infrastructure to transfer this water towards Windhoek as the most southerly demand node in the CAN system,
- Raw water transfer from the Okavango River as far as the VBWTP.

3.5.2 Water Demands to be Supplied

3.5.2.1 Supply Scenarios Modelled using the CA-Model

The concept schemes to be defined need to consider the water demands to be supplied. A number of supply scenarios were considered and modelled using the CA-Model, as shown in **Table 3.1**.

Table 3.1: Summary of Abstraction from the Okavango River for Different Supply Scenarios

Date	99% Security of Supply: Abstraction Volumes (Mm^3/a)				
	Scenario 7: Current Consumers	Scenario 9a: Including Augmentation to Omaruru, Otjiwarongo and Otjinene	Scenario 9b: Windhoek Demand +10%	Scenario 9c: Windhoek Demand +21%	Scenario 9d: Scenario 9c + Supply to NE Areas
2024/25	20.25	20.38	26.05	27.58	30.10
2029/30	27.81	28.52	37.77	40.06	45.87
2034/35	39.80	40.26	49.13	55.41	66.01
2039/40	52.37	52.98	58.45	66.39	82.03
2044/45	60.34	61.53	69.92	76.69	95.76
2049/50[2]	64.05	65.00	72.98	81.18	102.46

Note:
1. % denotes percentile values.
2. Figures for 2049/50 adjusted slightly to compensate for a statistical anomaly.
3. Scenarios 9b, 9c and 9d include augmentation to Omaruru, Otjiwarongo and Otjinene.
4. Additional 10% and 21% demands in Windhoek were included at the request of NamWater.

3.5.2.2 Proposed Water Supply Scenarios

The Consultant proposes that two water supply scenarios be defined for the concept schemes to be investigated; “low” and “realistic high” scenarios as per **Table 3.2**.

Table 3.2: Proposed Supply Options for Abstraction from the Okavango River

Demands to be Supplied	Supply Scenario Definition / Configuration	
	Low Supply Scenario:	**High Supply Scenario:**
	Current CAN Consumers (Scenario 7)	Current CAN Consumers
		Augmentation to Omaruru, Otjiwarongo and Otjinene
		Windhoek demand + 10%
		Supply to NE Areas
Date	**99% Security of Supply: Abstraction Volumes (Mm^3/a)**	
2024/25	20.25	27.28
2029/30	27.81	42.11
2034/35	39.80	57.99
2039/40	52.37	72.06
2044/45	60.34	86.76
2049/50	64.05[2]	91.90

Note:
1. % denotes percentile values.
2. Figure for 2049/50 adjusted slightly to compensate for a statistical anomaly.
3. Augmentation to Omaruru, Otjiwarongo and Otjinene included as this is likely to be required.
4. An additional 10% demand in Windhoek is included at the request of NamWater.
5. Supply to the NE areas entails supply to the currently undeveloped areas in the north-eastern Otjozondjupa and northern Omaheke Regions.

Approval of the water demands to be supplied via the concept schemes is required from the PSC.

3.5.2.3 Water Demands along the Pipeline Routes

The two proposed pipeline routes are discussed below. Both routes traverse areas which are not supplied with water and from which areas and communities requests for water supply are sure to originate.

The Consultant proposes that an area up to 10 km to either side of the pipeline be supplied with *raw water for livestock watering only*. The area distance of 10 km is based on a 7.5 km offset from the pipeline which corresponds with the nominal DWSSC requirement, according to which all new DWSSC schemes are designed, namely that livestock water points should be located at a maximum of 15 km apart, so that animals do not have to walk more than 7.5 km to a water point. A further 2.5 km offset from the pipeline(s) is proposed as a buffer service area because the pipeline passes through areas with limited alternative water sources. It is therefore reasoned that in order to obtain water, and in order to prevent overgrazing around the water points, livestock in these areas simply travel further to obtain water, as their main source of water, particularly in the dry season, will remain the proposed pipeline. The use of a 10 km off-set for the supply of water to livestock is consistent with the approach followed with the determination of the water demands in the Cuvelai area and the WWSA.

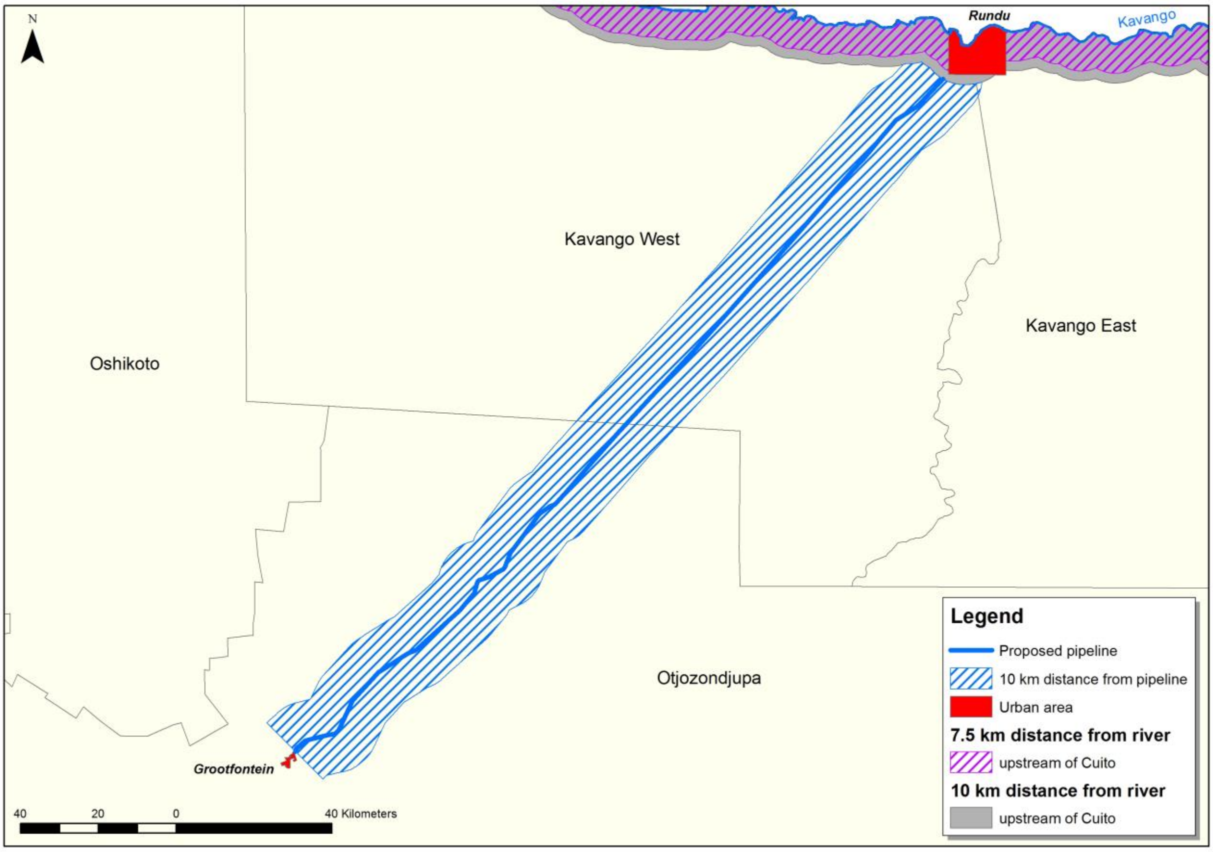
It is proposed that livestock numbers be determined based on an assumed carrying capacity of the rangeland of 10 ha/LSU, which will not be increased, as it is assumed that the capacity of the rangeland will not improve over time.

It is further proposed that human water demands within the off-set of the pipeline route be supplied from groundwater sources as is currently the DWSSC's policy in the Kavngo Region.

By way of example only, the 10 km off-set from a pipeline located parallel to the Rundu – Grootfontein tar road is provided in **Figure 3.1**. The area shown covers 4,881 km^2, or 488,100 ha, which would serve 48,810 large stock units, for which the annual water demand would be 801,704 m^3/a.

A policy decision is required by the MAWF regarding the areas along any pipeline route(s) which are to be served with water.

Figure 3.1: 10 km Off-set Area Along a Pipeline Route Between Rundu and Grootfontein (Example Only)



3.5.3 Pipeline Routes

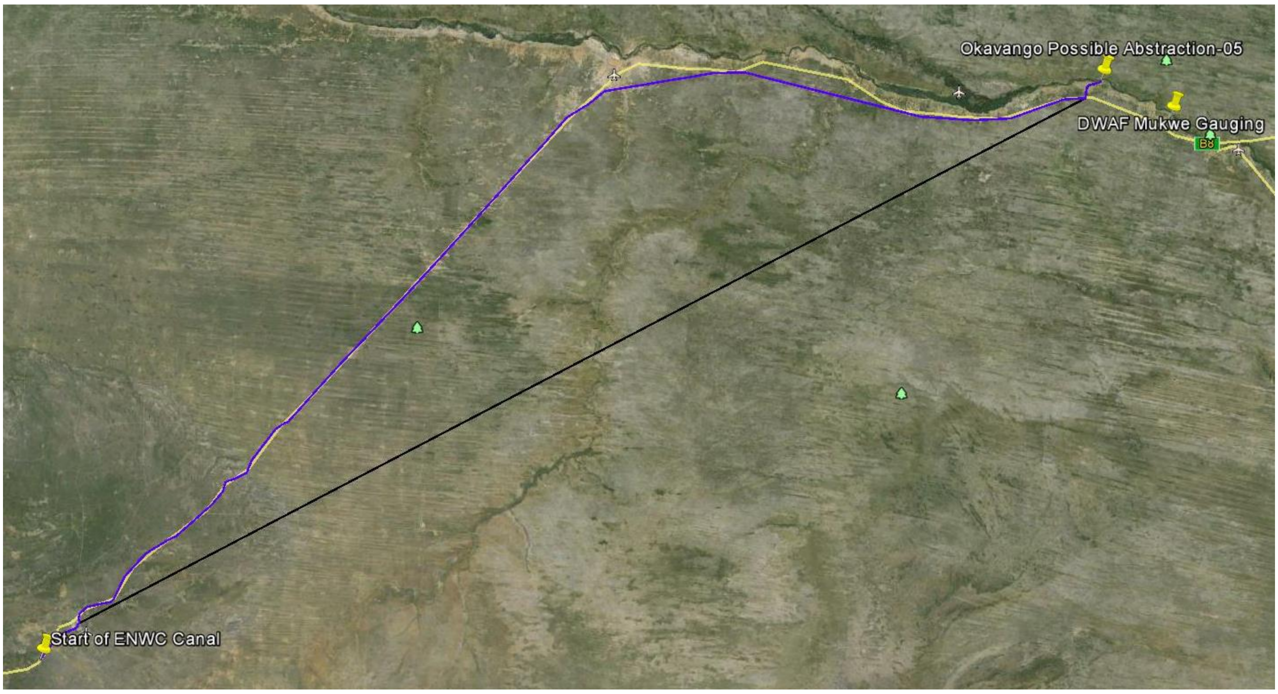
Two pipeline routes are proposed between a preliminarily sited abstraction point downstream of the confluence of the Okavango and Cuito Rivers and the start of the ENWC Canal outside Grootfontein, as follows:

1. Route 1: A pipeline along the B8 Grootfontein – Rundu – Bagani tar road as follows:
    a. The pipeline is envisaged to be within or along the edge of the road reserve, therefore within existing footprint areas,
    b. The pipeline will be laid along the southern side of the B8 tar road between Rundu and Bagani, generally following the road alignment, but not in all instances,
    c. The pipeline will be laid along the western side of the B8 tar road between Rundu and Grootfontein,
    d. The pipeline will be laid along the southern side of an existing road which "shortcuts" the corner made by the B8 tar road to the south of Rundu,
2. Route 2: A pipeline directly between the abstraction point and Grootfontein:
    a. The pipeline will be laid through largely undeveloped areas, which will require the provision of a new access road along most of its length,
    b. The pipeline will feature a similar route to that of the first from the southern side of Grootfontein to the start of the ENWC Canal.

The preliminarily proposed pipeline routes described above are provided in **Figure 3.2**. The characteristics of the preliminarily defined routes are as follows (Google Earth profile):

1. Route 1: Along the B8 Grootfontein – Rundu – Bagani tar road:
    a. Distance: 431 km,
    b. Elevation gain: 561 m,
2. Route 2: Directly between the abstraction point and Grootfontein:
    a. Distance: 393 km,
    b. Elevation gain: 583 m

Figure 3.2: Preliminary Pipeline Routes (Google Earth)



Notes:
1. Blue line indicates Route 1: The proposed pipeline route mostly along the along the B8 Grootfontein – Rundu – Bagani tar road.
2. Black line indicates Route 2: The proposed pipeline route directly between the abstraction point and Grootfontein.

Note: An alternative to Route 2 as described above, is a pipeline directly between the abstraction point and Mururani (approximately), from where the pipeline would follow the same alignment as Route 1 (adjacent to the B8 tar road). This has the advantage of shortening the route compared to the road via Rundu, but avoiding the necessity of crossing a number of commercial farms to the north east of Grootfontein, which would imply time-consuming negotiations with and permissions from a number of commercial farmers, with potential increased costs for compensation to these farmers.

Approval of these two pipeline routes to be investigated is required from the PSC.

3.5.4 Supply Configuration

The following supply configuration is proposed for both of the proposed pipeline routes:

1. Raw water transfer from the Okavango River as far as the VBWTP,
2. The water demands of the NE areas under the High Supply Scenario will be taken off at Grootfontein, for supply to the area via Otjituuo, as envisaged with previous master water plans,
3. The water demands of Otjiwarongo and Otjinene will be taken off at the Waterberg off-take along the ENWC Canal,
4. The water demands of Omaruru will be supplied from the Karibib WTP.

3.5.5 Pipeline Configuration

Two pipeline configurations are proposed for both of the proposed routes between the Okavango River and the start of the ENWC Canal outside Grootfontein, namely:

- Above-ground pipeline,
- Buried pipeline.

There are different advantages and disadvantages, and cost implications to these two configurations, which need to be investigated in more detail.

The pipeline diameters will depend on the water demands / flow rates to be transferred (refer above). Pipeline materials will be selected based on the availability and suitability of different materials for the diameters required and the different configurations. Suitable linings, if applicable, will be investigated as part of the overall assessment of the type of pipe materials to be used. The pressure rating of the pipes will be determined on the location and number of booster pump stations required and the resulting static and pump pressures in the different pipeline segments.

Approval of these two pipeline configurations to be investigated is required from the PSC.

3.5.6 Configurations to be Analysed

Three considerations are presented for the configuration of the supply scheme(s) (water demand / flow rate scenarios, pipeline routes and pipeline configurations), with two alternatives each, which results in eight possible combinations. It is not considered worthwhile to examine all eight combinations, and the ToR do not provide for this. A reduced number of combinations therefore needs to be considered for further analysis under Phase 3 of this Project.

The possible implications of the different considerations and alternatives need to be considered in order to evaluate which combinations are more worthwhile to investigate.

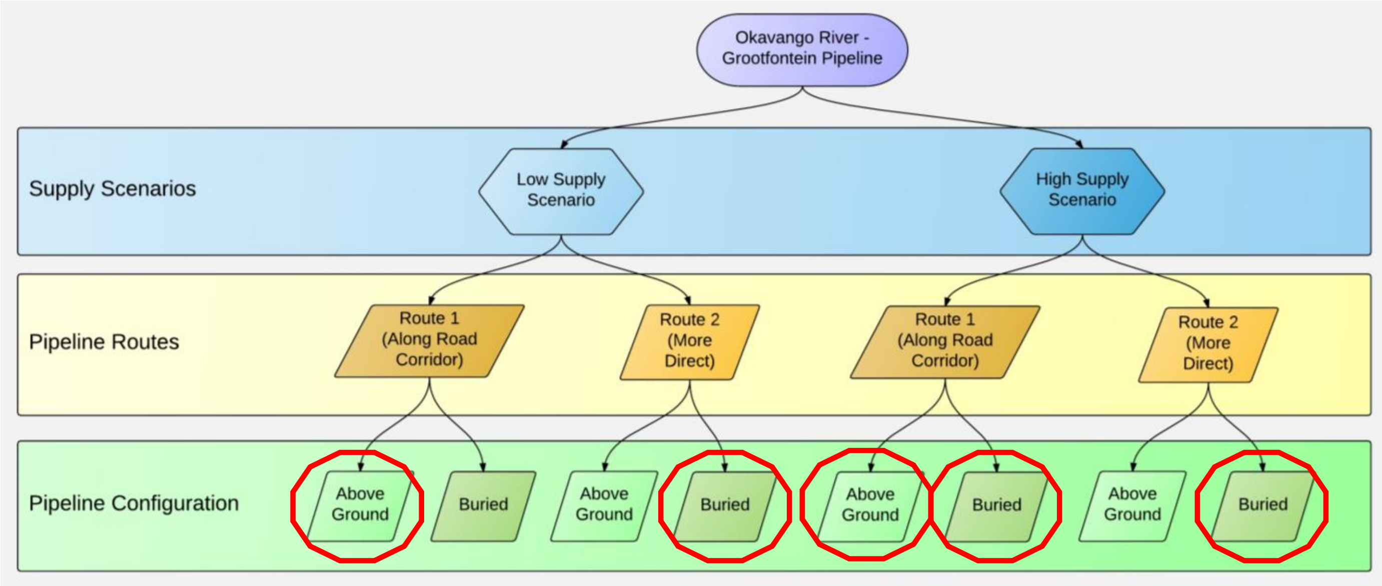
A very preliminary consideration of these implications are:

1. Low / High Demand Scenarios: The water demands to be supplied influence the following:
    a. The feasibility of abstraction from the Okavango River in the context of overall abstraction by Namibia and possible competing demands,
    b. The flow rates and therefore the pipeline diameters required. The pipeline diameters influence the availability of pipe materials (not all pipe materials are available in larger diameters) and pressure classes, which may limit the options regarding the pipeline configuration (above / below ground – not all materials are suitable to both applications),
2. Pipeline Routes:
    a. The length of pipeline influences the cost of the pipe material, but also the number of booster pump stations which may be required, and therefore may have a compounding impact on the costs,
    b. The shorter, more "direct" pipeline route will require the construction of an access road, which means that some or all of the savings on the pipeline may be off-set by the costs of the road, depending on the specifications of both,
    c. The environmental considerations will differ for the two pipeline routes proposed. A pipeline along Route 1 will be constructed largely within existing footprint areas, whilst a pipeline along Route 2 will entail infrastructure establishment in undeveloped and perhaps unspoilt areas,
3. Pipeline configuration. The above ground / buried pipeline options influence the following:
    a. Costs – it is not clear which option is cheaper,
    b. Maintenance and repair, which is easier with an above ground pipeline,
    c. Environmental and access considerations which may favour a buried pipeline.

It is possible that the advantages / disadvantages from one consideration may compound or off-set those of another consideration.

Figure 3.3 shows the eight possible combinations resulting from the above alternatives. Since not all eight combinations can be investigated, and it may not worthwhile to do so, five configurations (as per the ToR) have been selected for analysis. The selected options are circled in red in **Figure 3.3**.

Figure 3.3: Possible and Selected Pipeline Combinations or Alternatives

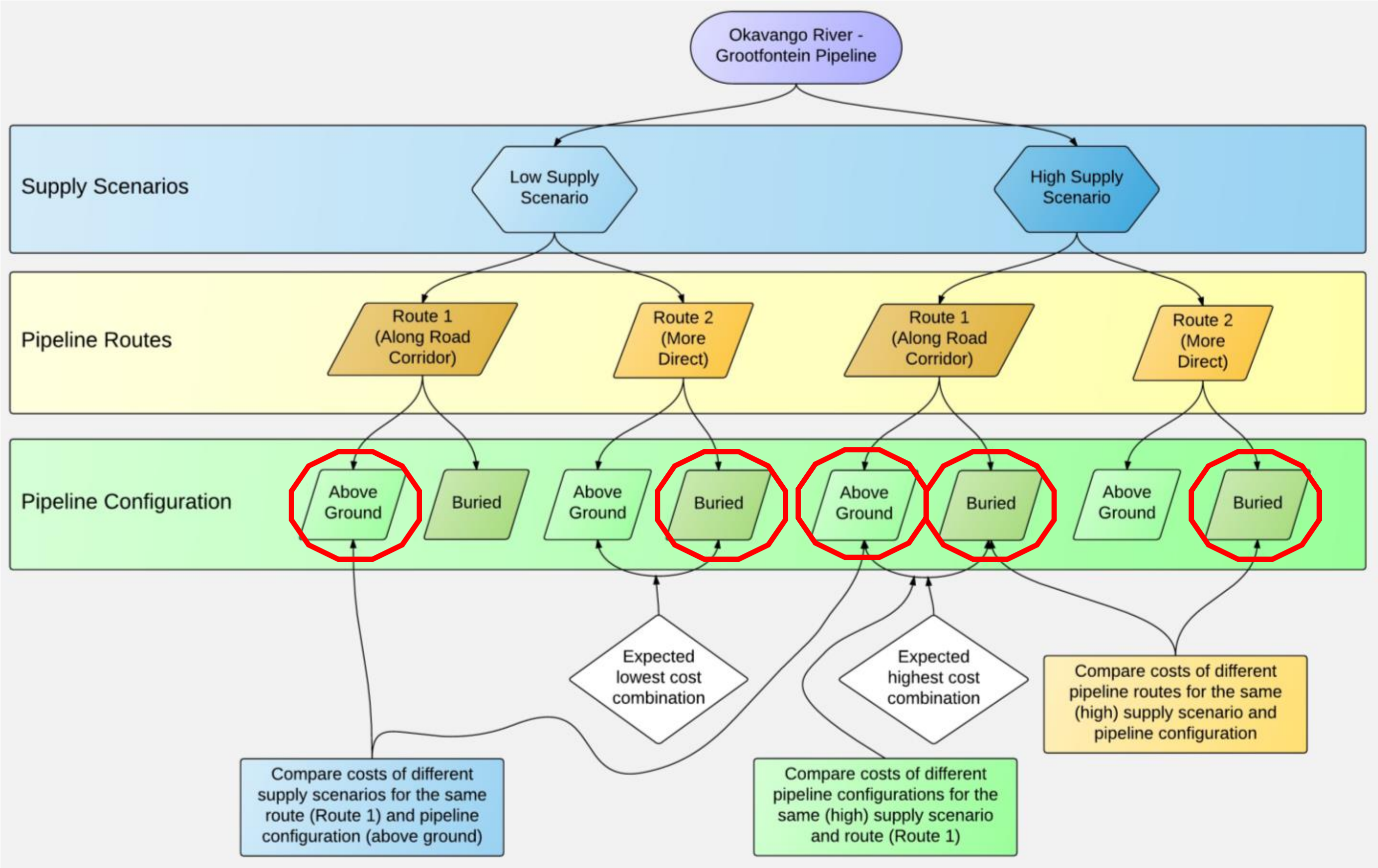


The five combinations shown have been selected on the basis of the following considerations:

1. In order to provide a possible "envelope" for the cost estimates, expected "high" and "low" cost combinations have been selected as follows:
    a. The high water supply scenario (larger pipeline diameter), laid over the longest route (Route 1) is expected to constitute the most expensive scenario. Which of the above ground or buried pipeline configurations will prove to be the most expensive is not known, and therefore both pipeline configurations are proposed for analysis,
    b. The low water supply scenario (smaller pipeline diameter), laid over the shortest route (Route 2) is expected to constitute the least expensive scenario. Which of the above ground or buried pipeline configurations will prove to be the least expensive is not known. It is proposed that the buried configuration be analysed, as a cost comparison between the pipeline configurations is possible through the other combinations proposed for analysis,
2. Providing a cost comparison between the different routes proposed (Route 1 or 2), for the same supply scenario (the high supply scenario is proposed) and pipeline configuration (a buried pipeline is proposed for this purpose),
3. Providing a cost comparison between the different supply scenarios proposed (high or low), for the same pipeline route (Route 1 is proposed) and pipeline configuration (an above ground pipeline is proposed),
4. Providing a cost comparison between the different pipeline configurations proposed (above ground or buried), for the same pipeline route (Route 1 is proposed) and supply scenario (the high supply scenario is proposed).

An explanation of the comparisons possible from the five selected options is provided in **Figure 3.4**: This selection of combinations is therefore expected to provide a direct cost comparison between the supply scenarios, pipeline routes and pipeline configurations proposed (all other variables being the same in each instance), as well as a lowest and highest cost estimate. It should be possible to derive a cost estimate for one of the combinations not proposed for analysis on the basis of the information available from the analysis of the five selected combinations.

Figure 3.4: Explanation of the Selected Pipeline Combinations or Alternatives



3.6 CAPACITY OF AND POTENTIAL UPGRADES TO EXISTING INFRASTRUCTURE

The concept schemes to supply raw water from the Okavango River to the CAN are all based on the use of the existing CAN transfer schemes and infrastructure south of Grootfontein (refer to **Section 3.5.1**), namely the following (existing capacity values in parentheses):

1. The Grootfontein – Omatako Eastern National Water Carrier Canal, with an assumed capacity of 2 m^3/s for a 20-hour operation day,
2. The Omatako – Von Bach Scheme, which consists of the following:
    a. Abstraction pipeline from the Omatako Dam to the Omatako Base Pump Station,
    b. The Omatako Base Pump Station (1 m^3/s),
    c. The Omatako – Otukarru Pump Main (pipeline; 2 m^3/s),
    d. The Omatako Booster Pump Station (1 m^3/s),
    e. The Otukarru Pressure Break Reservoir (4,000 m^3),
    f. The Otukarru – Von Bach Gravity Main (pipeline; 2.2 m^3/s).
3. The Von Bach Water Treatment Plant (0.89 – 1.8 m^3/s),
4. The Von Bach – Windhoek Scheme, which consists of the following:
    a. Von Bach Base Pump Station (2 m^3/s),
    b. Two Von Bach Booster Pump Stations (Booster 1 and Booster 2; both 2 m^3/s),
    c. A dual transfer pipeline (1.5 m^3/s for the 1,100 mm diameter pre-stressed concrete pipeline).

The capacity of these infrastructure components will be compared with the required transfer volumes or flow rates for each of the Low and High Supply Scenarios to be investigated. High-level cost estimates will be provided for any capacity upgrades which may be required in the immediate term. If any capacity upgrades are required in the medium or longer-term (after 2030 say), these will be flagged but not costed, on the basis that cost estimates provided for dates this far into the future are unlikely to be realistic.

The Consultant understands that the condition of the ENWC Canal is “poor”. An assessment of this Canal is not included in the scope of this Project. It is consequently proposed that a high-level cost estimate for rehabilitation / repair work be provided on the basis of a determination / estimate received from NamWater, who have assessed the canal relatively recently (May – July 2015).

The Consultant proposes that the Otukarru – Von Bach Gravity Main (pipeline) be extended or provided with a branch pipeline directly into the VBWTP, in order that water from the Okavango River is not discharged into Von Bach Dam, but rather fed directly into the VBWTP, with blending from the Dam, in order to avoid the evaporation of this relatively expensive water.

4. CONCLUSIONS

This Memorandum sets out the changes proposed to the Phases and configuration of the Project and the scheme configurations to be assessed under Phase 3 of the Project (as originally intended).

Approval of the following is required from the PSC:

1. Change of the Project scope, in that Phases 2 and 3 are to be combined, and no interim report is to be submitted for Phase 2 (as previously envisaged), in order to expedite the remaining work under the Engineering Component of this Project,
2. The proposed supply configuration for the Cuvelai Area, which is to be analysed further under the remaining work of this Project, including:
    a. The reduction in size of the Olushandja Dam,
    b. The provision of a large, new purification plant at Olushandja,
    c. The provision of a pipeline between the new purification plant at Olushandja and Oshakati, to replace the existing canal for the purposes of *potable water supply,* to include supply to Outapi and Ogongo (eventually),
    d. Limited supply from the Ohangwena II Aquifer, following a proposed well-field development in the vicinity of Eenhana / Okongo to one of the Ondangwa / Iindangungu / Omakango or Omafo Pump Stations for further distribution via the existing pipeline supply network,
    e. The construction of a pipeline from the Headbay (possibly also the Tailrace) at Ruacana to the Canal, to transfer only potable water for human and livestock water use in the Cuvelai Area,
    f. The introduction of non-potable reuse, initially in the urban areas of Oshakati, Ondangwa and Ongwediva, following a concerted public and general awareness campaign,
3. The proposed supply configurations for the CAN which are to be analysed further under the remaining work of this Project, including:
    a. The two demand / supply scenarios proposed,
    b. The supply configuration proposed,
    c. The two pipeline routes proposed,
    d. The two pipeline configurations proposed,
    e. The overall scheme combinations proposed.

A policy directive is required from the MAWF regarding the areas, people and animals to be supplied with water alongside the proposed pipeline routes between the Okavango River and Grootfontein.

5. APPROVAL OF REPORT

This report has been read and approved for submission to the Director: Infrastructure Development of the Department of Water Affairs and Forestry for concurrence. I support the proposals set out in the report and submit it to the Deputy Permanent Secretary of the Department of Water Affairs and Forestry for endorsement.

(V. Stinger) 04. 03. 2016

DEPUTY DIRECTOR: INFRASTRUCTURE DEVELOPMENT **DATE**

I endorse the proposals set out in the report and submit it to the Permanent Secretary of the Ministry of Agriculture, Water and Forestry for approval.

07/03/2016

DEPUTY PERMANENT SECRETARY: DWAF **DATE**

The proposals in this report have been decided upon as follows:

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PERMANENT SECRETARY
07-03-2016
Republic of Namibia
Ministry of Agriculture, Water & Forestry

07/03/2016

PERMANENT SECRETARY **DATE**